

REMARKS

Reconsideration of the above-identified application in view of the present amendment is respectfully requested.

The present amendment replaces the language "a secondary diol" in claims 20, 30, 32, 35, and 36 with the language "2,4-pentanediol". The amendment attempts to overcome the 35 U.S.C. §112, first paragraph, rejection on page 3, lines 8-12 of the Office Action. The Office Action states that:

"to recite a secondary alcohol with only one example in a chemical case, is to deprive the person of ordinary skill in the art of what is required to be effective, as to what m.w. alcohols are contemplated for this, whether both (or how many of for alcohols with plural hydroxyl groups) alcohol groups are contemplated as secondary or only one such group etc."

By reciting within claims 20, 30, 32, and 35 that the secondary diol is 2,4-pentanediol, this rejection is no longer relevant. Support for the limitation that the secondary diol is 2,4-pentanediol can be found in claims 31, 34, and 37 as well as the specification at page 13, line 10.

The present amendment also changes the term "being" in claims 20, 32, and 35 to "comprising". This change better defines the present invention and attempts to overcome the 35 U.S.C. §112 first paragraph and second paragraph rejections. Support for this change can be found in original claim 1 and pages 7 and 11 of the specification.

Further, the present amendment deletes the term "block" from the specification and the abstract. The term "block" was

deleted from the specification and the abstract to make the specification consistent throughout.

Moreover, the present amendment cancels claims 31, 34, and 37 because these claims recite that the secondary diol is 2,4-pentanediol and the term 2,4 pentanediol is now recited in the independent claims.

Additionally, the present amendment presents arguments and supporting references that attempt to overcome the other 35 U.S.C. §112, first paragraph and second paragraph rejections.

Thus, the present amendment merely reduces the number of issues for appeal by overcoming the 35 U.S.C. §112 rejections and canceling rejected claims. Moreover, since the limitations of claims 31, 34, 37 were under consideration prior to the final Office Action a showing under 37 C.F.R. §1.116(b) is not believed to be needed.

The Applicants respectfully apologize for not including a copy of the documents referred to in the last response to the Office Action. The following documents are attached and will be referred to in discussing the rejections:

- 1) Holden et al., Thermoplastic Elastomers, 2nd ed., pages 1-5 and 15-27, Hanser/Gardner Publications, Inc. Cincinnati, 1996. (hereinafter, "Thermoplastic Elastomers").
- 2) Kirk-Othmer, Encyclopedia of Chemical Technology, 4th ed., Volume 9, pages 15-37, John Wiley and Sons, Inc. 1994. (hereinafter, "Encyclopedia of Chemical Technology").
- 3) Bhowmick et al., Handbook of Elastomers, New Developments and Technology, pages 375-376, Marcel Dekker, Inc. (hereinafter, "Handbook of Elastomers").

- 4) Billmeyer, Fred, Textbook of Polymer Science, 3rd ed., pages 4, 101, and 379, John Wiley and Sons Inc. 1984. (hereinafter, "Textbook of Polymer Science").
- 5) Whittington, Lloyd, Whittington's Dictionary of Plastics, pages 54 and 59-60, Technomic Publishing Co., Inc. 1968. (hereinafter, "Whittington's Dictionary of Plastics")
- 6) Lewis, Richard, Hawley's Condensed Chemical Dictionary, 12th ed., page 325, Van Nostrand Reinhold Company, 1993. (hereinafter, "Hawley's Condensed Chemical Dictionary")

The 35 U.S.C. §112 first paragraph and second paragraph rejections in the November 6, 2001 Office Action will first be discussed. A discussion of the 35 U.S.C. §103 rejection in the November 6, 2001 Office Action will then be presented.

**I. 35 U.S.C. §112, first paragraph, rejections.**

Claims 20-31 were rejected under 35 U.S.C. §112, first paragraph, as containing subject matter, which was not described in the specification in such a way as to reasonably convey to one skilled in the art that the inventor, at the time the application was filed, had possession of the claimed invention.

The Office Action first states that the change to delete the term "block" is per se okay, but that it has not been carried out uniformly throughout; therefore, the specification not only remains incorrect but inconsistent throughout.

As noted above the abstract and the paragraph beginning at line 5, of page 3 have been amended to delete the term "block" from these paragraphs. Thus, the specification is now consistent and uniform throughout.

The Office Action also states that the basis for the added amounts as in claim 35, newly recited ingredients as in claim 21, and so on, has not been pointed out and that the Applicant is required to point out the basis for such newly claimed terms, or to cancel them.

The ingredients listed in claim 21 can be found in the specification on page 8, lines 6 and 7, which state that the preferred linear energetic polymer is glycidyl azide polymer and page 9, lines 3-13, which lists other linear energetic polymers that can be used in the present invention.

The amounts listed in claim 35 can be found in the specification on page 6, lines 23-24, which states that the preferred amount of inorganic salt oxidizer is in the range of about 65% to about 90% by weight based on the weight of the gas generating material, and page 13, lines 22-24, which states that a preferred weight % of thermoplastic elastomer is from about 5% to about 35% based on the weight of the gas generating material.

Additionally, the Office Action asserts: (i) that block copolymers must be derived from two different monomers, such as described in U.S. Patent No. 5,552,257 (ii) that a reaction of hydroxyl terminal groups with an isocyanate to produce a polyurethane is distinctly different than a reaction to form a block polymer; (iii) that referring to toluene diisocyanate as a block is entirely wrong and to refer to a diisocyanate residue of any simple diisocyanate as a block or segment, which may be thermoplastic, is wrong; and (iv) that

the idea of physically cross-linking is not correctly conveyed to one skilled in the art.

Claims 20-36 are described in the specification in such a way as to reasonably convey to one skilled in the art that the inventor, at the time the application was filed, had possession of the claimed invention because the terms and language used to describe the invention are in conformance with those terms and language used by one skilled in the art.

The Encyclopedia of Chemical Technology on page 17, lines 18-20 states that:

"Five block copolymers are of commercial importance: poly(styrene-b-elastomer-b-styrene), thermoplastic polyurethanes, thermoplastic polyesters, thermoplastic polyamides, and polyetherimide-polysiloxane block copolymers."

The Encyclopedia of Chemical Technology also states, on page 24, lines 4-22, one method of forming a thermoplastic polyurethane block copolymer. In this method, a high molecular weight polyester or polyether with terminal hydroxyl groups is reacted with a diisocyanate and a secondary diol to form a "block copolymer" with an  $(A-B)_n$  structure.

It is further indicated in the reaction equation on page 24 of this document that the copolymerized polyester or polyether in this block copolymer forms the "soft rubbery segments" of the block copolymer, while the diisocyanate forms the "hard crystalline segments" of this block copolymer.

Thermoplastic Elastomers also teaches, on page 16, lines 41+ and page 17, lines 1-21, that TPUs (i.e., thermoplastic polyurethane elastomers) are multiblock polymers that include

one block that forms a hard segment and a second block that forms a soft segment. One type of block, the hard segment is formed by a chain extender, such as butane diol, and a diisocyanate, such as MDI. This hard segment is indicated in Fig. 2.1 on page 17 as comprising a urethane group. The other type of block is formed by the flexible polyether or polyester. (See page, 17, Fig. 2.1 and page 17, lines 3-6) It is the soft segments that give the elastomeric properties the thermoplastic elastomer (page 17, lines 14-15), "with the hard segments acting as multifunctional tie points that function both as physical cross-links and reinforcing fillers" (page 17, lines 17-21).

Thermoplastic Elastomers, on page 17, lines 17-21, also states that:

"the TPU network was described as 'virtually cross linked'. To obtain thermoplasticity, the average functionalities of the starting materials should be close to 2.00. That is, each prepolymer or monomer unit should have 2 terminal reactive groups. This ensures formation of the high molecular weight linear chains with no or only very few branch points."

Section 2.4.1 on page 25 of Thermoplastic Elastomers further adds that the hard segments which are comprised of the diisocyanate are expected to be crystalline and X-ray analysis of single crystals of these compounds revealed hydrogen bonds between neighboring urethane, which promote physical cross-linking.

Additionally, with regard to physical cross-linking in thermoplastic polyurethane elastomers, the Handbook of

Elastomers states, at page 375, lines 1-7, that to be useful in mechanical applications, the polymer chains of rubber-like elastomers (which are not thermoplastic) must be joined together in lateral fashion by covalent chemical cross-linking by a process known as vulcanization or curing.

"However, it was subsequently recognized that very high level, useful mechanical properties can be obtained by amorphous, low-Tg polyurethane elastomer systems that are essentially linearly structured, thermoplastic and therefore devoid of chemical cross-links. This phenomenon was attributed to tie points among the linear polyurethane chains that are reversible with heat or solvation, and the term 'virtual cross-link' (VC), i.e., 'cross-linked in effect but not in fact, was applied to such tie points... Published views bearing on the nature of virtual cross links in TPUs include hydrogen bonding among urethane-group hydrogen atoms and carbonyl groups."

Referring now to the language in the specification of the present application to which the Office Action states is misdescriptive, the present application on page 7, lines 14-16 states that:

"The polyurethane thermoplastic elastomer of the present invention comprises linear block copolymers that are physically cross-linked by hydrogen bonds."

This statement is neither misdescriptive nor incorrectly conveyed to one skilled in art.

First, it is well known in the art (as shown in Encyclopedia of Chemical Technology at page 17, lines 18-19; page 24, lines 4-22; and page 25, Table 4) that polyurethane thermoplastic elastomers can be formed from linear block copolymers.

It is also shown in the Handbook of Elastomers that the cross-linking of polyurethane thermoplastic elastomers by hydrogen bonds is known to one of ordinary skill in the art. Specifically, the Handbook of Elastomers states that

"Published views bearing on the nature of virtual cross links in TPUs include hydrogen bonding among urethane-group hydrogen atoms and carbonyl groups." (Page 376, lines 1-2).

This language in the patent application is further supported on page 17, lines 14-21 of Thermoplastic Elastomers, which is also note above.

Thus, the Applicants fail to see how this language is misdescriptive or incorrect.

Referring now to page 10, lines 3-11 of the present application recite:

"The isocyanate groups of the aromatic diisocyanate and the hydroxyl groups of the linear energetic polymers react, in urethane type reaction, to form a linear block copolymer with urethane linkages."

The Office Action states that this language is misdescriptive because the reaction to form a block copolymer is distinctly different than the reaction to form a polyurethane.

The Applicants respectfully disagree with this statement. Both the Encyclopedia of Chemical Technology and Thermoplastic Elastomers show that a urethane type reaction between the terminal hydroxyl groups of a polymer and a diisocyanate can form a block copolymer, which is a polyurethane. (See Encyclopedia of Chemical Technology page 24, liens 4-22, and Thermoplastic Elastomers sections 2.2 and 2.3, pages 17-24).



The only difference in the process of forming the block copolymers of the present invention and the process described in the references is that in the present invention the use of a chain extender, i.e., the secondary diol in the present invention, was found to be optional in the formation of the block copolymer.

The reaction product of the present invention, however, can still be considered a block copolymer even without the secondary diol. The reaction product of the energetic polymer and the diisocyanate of the present invention would include a first block. The first block would comprises the repeating unit that makes up the energetic polymer. The second block would comprise the two urethane groups that that are formed from the reaction of the diisocyanate. The Applicant understands that the urethane groups do not form a repeating segment unless the secondary diol is added. The Applicant however has found that the two urethane groups formed by the reaction of the aromatic diisocyanate formed a hard crystalline segment like the hard crystalline segment described on page 24 of the Encyclopedia of Chemical Technology. Therefore, the Applicant believed that to refer to the reaction product of the energetic polymer and the diisocyanate as a block copolymer was not misdescriptive because the reaction product was a copolymer (i.e., a polymer of two chemically distinct monomers-See attached definition in Whittington's Dictionary of Plastics) and also included a first block defined by the repeating unit of the energetic polymer and a second block defined by repeating (i.e., two)

urethane linkages. Regardless, the term block was eliminated from the specification in last Office Action.

The Office Action also rejects this language by stating that to refer to any isocyanate group as a block or segment is wrong.

The Applicant would first like to point out that no where in the specification is the isocyanate group referred to as a block or segment. Only the thermoplastic segments, which are provided by the urethane linkages, are referred as a segment. Referring to the urethane groups formed by the reaction of the diisocyanate as a block or segment is not misdescriptive. Fig. 2.1 on page 17 of Thermoplastic Elastomers refers to the hard segment as including the urethane group and diisocyanate. Section 2.2.2.1 beginning on page 21 of Thermoplastic Elastomers teaches specifically that diisocyanates can comprise the hard segment.

Referring now to page 10, lines 9-11 of the present application, these lines state that:

"The elastomeric segments are provided by the linear energetic polymer and the thermoplastic segment are provided by the urethane linkages."

With regard to this language the Office Action states that to refer to the isocyanate residue of any simple diisocyanate as a block or segment which may be "thermoplastic" is wrong and contrary to ordinary terms in the art.

The Applicant respectfully disagrees that to refer to the urethane linkages as a thermoplastic segment is wrong and contrary to ordinary terms in the art.

As previously noted, the Encyclopedia of Chemical Technology teaches at page 24 that the polymer used in forming the thermoplastic polyurethane elastomer forms an "elastomeric or soft segment in the final polymer". The Encyclopedia of Chemical Technology does not teach that isocyanates forms thermoplastic segments; however, the Encyclopedia of Chemical Technology does teach at page 21 that the hard segment determines the melting point of the thermoplastic polyurethane elastomer. Thermoplastic Elastomers further teaches on page 22 that the hard segment determine the glass transition temperature of the thermoplastic polyurethane elastomer. Thus, the prior art teaches that the soft segments are elastomeric segments and that the hard segment of the thermoplastic polyurethane elastomer provides the "thermoplastic" characteristics to the thermoplastic polyurethane. Therefore, given that Applicant is ordinarily afforded some latitude in describing the invention, to refer the hard segments of the thermoplastic polyurethane elastomer as the thermoplastic segments would not be wrong or contrary to ordinary terms of the art.

The Office Action further argues that,

"to recite a secondary alcohol with only one example in a chemical case, is to deprive the person of ordinary skill in the art of what is required to be effective, as to what m.w. alcohols are contemplated for this, whether both (or how many for alcohols with plural hydroxyl

groups) alcohol groups are contemplated as secondary or only one such group, etc."

As noted above, claims 20, 32, and 35 have been amended to recite that the secondary diol is 2,4-pentanediol. Therefore, claims 20, 32, and 35 are enabled.

The Office Action also states that the idea of physical cross-linking is not correctly conveyed to one of ordinary skill in the art, that it is not clear what the difference between what Applicant does and what Hawley's teaches occurs for all polyurethane elastomers, and that this basis is not sufficient for perverting ordinary art understood language.

First, it is noted that the difference between the present invention and the description in Hawley's is that the present invention relates to a thermoplastic polyurethane elastomer while Hawley's describes a polyurethane elastomer, which is not a thermoplastic. The distinction between a polyurethane elastomer and a thermoplastic polyurethane elastomer is noted in the Handbook of Elastomers.

Second, the description in the application of thermoplastic polyurethane elastomers does not pervert ordinary understood language. As noted above, it is well known those skilled in the art that thermoplastic polyurethane elastomers can be physically cross-linked by hydrogen bonds.

For example, Thermoplastic Elastomers teaches that hard segments of the thermoplastic polyurethane elastomer act as multifunctional tie points that function both as physical cross-links and reinforcing fillers. (page 17, lines 17-21). Section 2.4.1 on page 25 of Thermoplastic Elastomers further

adds that the hard segments which are comprised of the diisocyanate are expected to be crystalline and X-ray analysis of single crystals of these compounds revealed hydrogen bonds between neighboring urethane which promote physical cross-linking.

Additionally, the Handbook of Elastomers states that it was recognized that very high level, useful mechanical properties can be obtained by amorphous, low-Tg polyurethane elastomer systems that are essentially linearly structured, thermoplastic and therefore devoid of chemical cross-links. This phenomenon was attributed to tie points among the linear polyurethane chains that are reversible with heat or solvation. Published views bearing on the nature of the cross links in TPUs include hydrogen bonding among urethane-group hydrogen atoms and carbonyl groups.

This description is in agreement with the description on page 11, lines 6-11 of the present application, which states,

"Each of the urethane linkages within the copolymers so formed are capable of forming hydrogen bonds with an oxygen of the urethane linkage of another linear copolymer or with an oxygen of the linear energetic polymer of another linear energetic copolymer. By doing so, the linear copolymers physically cross-link and form the polyurethane thermoplastic elastomer."

Thus, idea of physical cross-linking of the thermoplastic polyurethane elastomers is properly conveyed to one skilled in the art.

The Office Action also states that:

"In discussing Ziegler in the reply, in contrast to the prior art teachings and in Hawley, it is clear that Applicant's attorney, at least, needs considerable education in polymer science, as there is essentially nothing that is argued which is either true, or even makes sense, to one of ordinary skill in the art."

The Applicant's attorney will attempt to restate his argument concerning the Zeigler reference with greater precision and clarity. This discussion will not be included here, but made below with respect to the 35 U.S.C. §103(a) reference.

**II. 35 U.S.C. §112, second paragraph, rejections**

Claims 20-37 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter, which Applicant regards as the invention.

The Office Action states that the language in the claims is incorrect, cannot be understood by the person of ordinary skill in the art, and fails to set forth the metes and bounds of the claimed invention.

First, the Office Action states it is not clear what is required by the "thermoplastic elastomer" language; particularly since the language does not specify any particular "linear energetic polymer", but merely recites what would be required for an ordinary polyurethane polymer.

The Applicant respectfully disagrees with the Office Action that the "thermoplastic elastomer" language is indefinite.

The "thermoplastic elastomer" language is not indefinite because the term is used consistently with prior art teachings and the term is clear to a person of ordinary skill in the art. The Textbook of Polymer Science states on page 379, second paragraph, that:

"The term *thermoplastic elastomers* is currently used to describe a wide variety of materials that have elastomeric properties at ambient temperatures, but process like thermoplastics, obviating the need for the vulcanization step to develop typical rubber like elasticity.

The thermoplastic elastomer of the present invention is consistent with this definition.

The use of the term "linear energetic polymer" is also consistent with prior art teachings. Energetic polymers are well known in the art as disclosed in U.S. Patent No. 5,741,998 (a copy of which is attached).

As to what is required by the thermoplastic elastomer of the present invention, it is required that the thermoplastic elastomer (i) be a thermoplastic elastomer, (ii) comprise a polyurethane, (iii) and that one of the ingredients used in forming the polyurethane be a linear energetic polymer.

As noted in Thermoplastic Elastomers and Handbook of Elastomers not all polyurethanes form elastomers and not all polyurethane elastomers are thermoplastics. Thus, the polyurethane of the present invention is distinguished from all polyurethanes in that (i) it forms a thermoplastic elastomer and (ii) it is formed using a linear energetic polymer. Therefore, what is required for the "thermoplastic

elastomer" language in claim 20 is clear to a person skilled in the art.

Second, the Office Action states that it is pointed out that "less than 2" functionality for the hydroxyl includes zero, the "energetic" polymer recitation does not require any hydroxyl groups, and a secondary diol may form a polyurethane.

The use of the language "two or less" in claim 20 is not indefinite. The language "two or less" is used to merely recite the maximum hydroxyl groups that the linear energetic polymer can have when reacting with the diisocyanate to form the thermoplastic elastomer of claim 20. Claim 20, when viewed in light of the specification, requires that the linear energetic polymer must have some hydroxyl functionality to react with the diisocyanate to form a polyurethane, but that this hydroxyl functionality is two or less. Moreover, it well settled that:

"The imposition of a maximum limit on the quantity of one of the reactants without specifying a minimum does not warrant distorting the overall meaning of the claim." In re Kirsch, 182 USPQ 286, 290 (CCPA 1974).

Third, the Office Action states that the claim language of "aromatic diisocyanate" and "a linear energetic polymer" at best only forms a polyurethane to one of ordinary skill in the art.

The Applicant respectfully disagrees the claim language "aromatic diisocyanate" and "linear energetic polymer" at best only forms a polyurethane. The definiteness of the language employed in the claim must be analyzed not in a vacuum, but in



light of the particular application disclosure and the prior art teachings as it would be interpreted by one of ordinary skill in the art. In re Angstadt, 537 F.2d 498, 190 USPQ 214, 217, (C.C.P.A. 1976). One of ordinary skill in the art reading the specification would realize that an aromatic diisocyanate and a "linear energetic polymer" can be used to form a thermoplastic elastomer. Moreover, both Thermoplastic Elastomers and Encyclopedia of Chemical Technology teach that thermoplastic elastomers can be formed from polyurethanes, which are made using aromatic diisocyanates and a polymer. Thus, the specification and the prior art teachings do not suggest that the "aromatic diisocyanate" and the "linear energetic polymer" "at best" only form a polyurethane.

Moreover, it is not the normal function of the claims to disclose the invention but to point out the features of novelty in the invention as disclosed in the specification. Bocciarelli v. Hoffman, 109 USPQ 385, 388 (C.C.P.A. 1956). Claim 20 does not attempt to disclose the invention, but instead point out the novel features of the invention. Thus, one looking at claim 20, without considering the specification and the prior art teachings, may arrive at the conclusion that "at best only a polyurethane would be formed", but this conclusion would be improper because the claims must be viewed in light of the specification and the prior art teachings.

Fourth, the Office Action states that the terms "segment" and "elastomer" as used lack proper factual basis.

The Applicant respectfully disagrees that the terms "segment" and "elastomer" lack proper factual basis. The use

of both these terms in relation to thermoplastic polyurethane elastomers is well known in the art as shown on pages 16-22 of Thermoplastic Elastomers and pages 20-24 of Encyclopedia of Chemical Technology. Moreover, these terms are supported by the specification. Thus, the terms "elastomer" and "segment" have a factual basis.

Additionally, the Applicant fails to see where in claims 20-37 the term "segment" is even mentioned. The Applicant requests that the Office Action please specify where the term "segment" is used in the claims.

Fifth, the Office Action states that the amount of the segment of the polymer does not make sense.

The Applicants fail to see where in claims 20-37 the amount of a segment is mentioned or where the term segment in claims 20-37 is used at all. The Applicant requests that the Office Action please specify where the term "segment" is used in the claims and where the language "amount of segment" is used in the claims.

Finally, the Office Action states that it is not clear if claim 36 requires a secondary diol, since claim 35 states that it is optional. Claim 36 depends from claim 35 and further limits claim 35 to the specific components of claim 36. Since claim 36 positively recites that the secondary diol is included, then the secondary diol is required for the invention defined by claim 36. The Applicant, once again, fail to see how this language is indefinite. It is common practice in claim drafting to first recite an element in the alternative expression and then recite the element positively

in a dependent claim. For example, an element may be recited in an alternative manner in a Markush group, and the later claimed separately in a dependent claim.

**III. 35 U.S.C. §103(a), rejection**

Claims 20-37 were rejected under 35 U.S.C. §103(a) as being unpatentable over Re. 36,296 to Zeigler in view of U.S. Patent No. 5,164,521 to Manzara et al., U.S. Patent No. 4,393,199 to Manser, and U.S. Patent No. 5,319,037 to Gomez.

Claim 20 is patentable over Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. because Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest (1) a thermoplastic elastomer that comprises a polyurethane and (2) that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

As noted in the Office Action Zeigler teaches the basic idea of an air bag system with a gas generating composition that comprises an oxidizer of ammonium nitrate, a fuel (e.g., HMX or RDX), and an energetic GAP binder. Zeigler further states that:

"These materials are normally liquid materials and need to be formulated with an appropriate amount of a suitable curative to crosslink the material, e.g., from about 10-15% by weight based on the weight of binder of a multifunctional isocyanate such as hexamethylene diisocyanate and/or 4,4'-

diisocyanatodicyclohexyl-methane."  
(Column 4, lines 7-12).

Zeigler does not teach or suggest that the cross-linked glycidyl azide polymer forms a thermoplastic elastomer. Zeigler teaches that a suitable curative is used to cross-link the glycidyl azide polymer. In fact, a binder, which is cured by cross-linking, is generally not considered to be thermoplastic. To support the assertion that a binder, which is cured by cross-linking, is generally not considered to be a thermoplastic, the Applicant first refers to Whittington's Dictionary of Plastics. Whittington's Dictionary of Plastics at page 59 and 60 defines the term "cured" as,

"To change the properties of a plastic or resin by chemical reaction, which for example may be condensation, polymerization, or addition; usually accomplished by the action of either heat or catalyst or both, and with or without pressure. The term cure is used almost exclusively in connection with thermosetting plastics, vulcanizable elastomers and rubbers."

Additionally, Hawley's Condensed Chemical Dictionary on page 325 defines cross-linking as the,

"Attachment of two chains of polymer molecules by bridges, composed of either, an element, a group, or a compound, which join certain carbon atoms of the chains by primary chemical bonds."

Hawley's Condensed Chemical Dictionary further notes that,

"cross-linking has the effect of changing a plastic from thermoplastic to thermosetting".

Thus, Whittington's Dictionary of Plastics teaches that curing is used in conjunction with thermosetting plastics and

Hawley's Condensed Chemical Dictionary teaches that cross-linking changes a plastic form thermoplastic to thermosetting. If a "suitable curative" is used to "crosslink" the glycidyl azide polymer, a person skilled in the art would assume, based on the definitions of "cure" and "cross-link", that a thermosetting material is formed, not a thermoplastic material. Therefore, there is nothing in Zeigler that teaches or suggests that the glycidyl azide polymer cross-linked by the multifunctional isocyanate forms a thermoplastic elastomer.

Additionally, Zeigler does not teach using an aromatic diisocyanate and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Manzara et al. teach a hydroxyl terminated poly(glycidyl azide) with a hydroxyl functionality of up to 4 or more. Manzara et al. further teach that when using GAP as a binder for a solid rocket propellant GAP can be mixed with a polyisocyanate curing agent.

Manzara et al. do not teach that the glycidyl azide polymers can be formed into thermoplastic elastomers.

Manzara et al. teach that the glycidyl azide polymer can be combined with a polyisocyanate curing agent and heated to a cure temperature until a solid, elastomeric polyurethane matrix is formed (column 16, 4-13). There is no suggestion in Manzara et al. that this polyurethane matrix is a thermoplastic elastomer.

Manzara et al. also teach that glycidyl azide polymers converted to polyurethanes have good mechanical properties over the temperature range of -50°C to 120°C but can be advantageously be decomposed at temperatures below 130°C-150°C. (Col. 16, lines 46-48). Decomposition of a glycidyl azide polyurethane at temperatures below 130°C-150°C indicates that the polyurethane is not a thermoplastic. Thermoplastics do not decompose at temperatures below 130°C-150°C, but instead generally melt. Thus, there is nothing in Manzara et al. that discloses or suggests a thermoplastic elastomer that is a polyurethane.

Additionally, there is nothing in Manzara et al. that discloses or suggests that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Manser teach that block polymers such as THF and BDO can be formed with functionalities ranging from 0 to 4 (column 6, lines 35-47). Manser further teaches that if a difunctional polymer is copolymerized with a monomer, such as a diisocyanate, a linear copolymer will result and that if a trifunctional polymer is copolymerized with a diisocyanate, a cross-linked polymer will result. (Column 6, lines 49-67). Manser teach difunctional and trifunctional polymers can be mixed to control with exactitude the cross-linking density.

Manser does not teach that block polymers such as THF and BDO can be copolymerized with a monomer such as a diisocyanate to form a thermoplastic elastomer. Manser, as noted above, teaches controlling the cross-linking density of the polymer. A cross-linked polymer would not be a thermoplastic elastomer because the cross-linking would inhibit thermoplastic behavior.

Additionally, as discussed with regard to Manzara et al., there is nothing that discloses or suggests that the amount of aromatic diisocyanate, and linear energetic polymer used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Ochoa Gomez et al. teach a method of synthesizing a glycidyl azide polymer with a hydroxyl functionality of two or more from polyepichlorohydrin.

Ochoa Gomez et al. do not teach reacting the GAP polymer with an aromatic isocyanate to form a thermoplastic elastomer or controlling the amount of aromatic diisocyanate, glycidyl azide polymer, and secondary diol so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Thus, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not teach thermoplastic elastomer which is a polyurethane formed from glycidyl azide polymer, an aromatic diisocyanate, and optionally 2,4 pentanediol. Moreover, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not teach controlling the amount of aromatic

diisocyanate, glycidyl azide polymer, and 2,4 pentanediol so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 20 is patentable over Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al., and allowance of Claim 20 is respectfully requested.

Claim 21 depends from claim 20 and further recites that the linear energetic polymer is selected from the group consisting of glycidyl azide polymer, poly-glycidyl nitrate, poly-nitratomethyl-methyl oxetane, poly-bisazido-methyloxetane, poly-azidomethyl-methyloxetane, poly-nitraminomethyl-methyloxetane, and diethyleneglycoltriethyleneglycolnitraminodiacetic acid.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 21 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 21.

Claim 22 depends from claim 20 and further recites that the aromatic diisocyanate is 4,4'-methylene bis-phenylisocyanate.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not



disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 22 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 22.

Claim 23 depends from claim 20 and further recites that the linear energetic polymer is glycidyl azide polymer with a hydroxyl functionality of two or less.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 23 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 23.

Claim 24 depends from claim 23 and further recites that the glycidyl azide polymer has a molecular weight from about 25,000 g/mole to about 35,000 g/mole and a hydroxyl functionality of 2.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a

polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Moreover, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. glycidyl azide polymer has a molecular weight from about 25,000 g/mole to about 35,000 g/mole and a hydroxyl functionality of 2. Therefore, claim 24 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 24.

Claim 25 depends from claim 20 and further recites that the inorganic salt oxidizer is selected from the group consisting of alkali metal nitrates, alkaline earth metal nitrate, alkali metal perchlorates, alkaline earth metal perchlorates, ammonium perchlorate, and ammonium nitrate.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 25 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 25.

Claim 26 depends from claim 20 and further recites that the inorganic salt oxidizer is phase stabilized ammonium nitrate.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 26 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 26.

Claim 27 depends from claim 20 and recites that the gas generating material further comprises a supplemental fuel.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 27 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 27.

Claim 28 depends from claim 27 and further recites that the supplemental fuel is cyclotrimethylenetrinitramine.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate,

linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 28 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 28.

Claim 29 depends from claim 20 and further recites that the components of the gas generating material are present in a weight ratio adjusted to produce upon combustion a reaction gas product that consists essentially of carbon dioxide, nitrogen, and water.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 29 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 29.

Claim 30 depends from claim 20 and further recites that the polyurethane is formed from an aromatic diisocyanate, a linear energetic polymer with a hydroxyl functionality of two or less, and 2,4 pentanediol.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a

polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Moreover, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a polyurethane is formed from an aromatic diisocyanate, a linear energetic polymer with a hydroxyl functionality of two or less, and 2,4 pentanediol. Therefore, claim 30 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 30.

Claim 32 recites an apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited produces gas to inflate the inflatable vehicle occupant protection device. The gas generating material comprises an inorganic oxidizer salt and a thermoplastic elastomer. The thermoplastic elastomer comprises a polyurethane formed from an aromatic diisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and optionally 2,4 pentanediol. The amount of aromatic diisocyanate, glycidyl azide polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to the hydroxyl groups used to form the polyurethane thermoplastic elastomer is about 1.

Claim 30 contains limitations similar to claim 20. As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose

or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 32 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 32.

Claim 33 depends from claim 32 and further recites that the aromatic diisocyanate is 4,4'-methylene bis-phenylisocyanate.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 33 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 33.

Claim 35 recites an apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited produces gas to inflate the inflatable vehicle occupant protection device. The gas generating material comprises about 65% to about 90%, by weight of the gas generating material, an inorganic oxidizer salt and about 5% to about 35%, by weight of the gas

generating material a thermoplastic elastomer. The thermoplastic elastomer comprises a polyurethane formed from 4,4'-methylene bis-phenylisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and optionally 2,4 pentanediol. The amount 4,4'-methylene bis-phenylisocyanate, glycidyl azide polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to the hydroxyl groups used to form the polyurethane thermoplastic elastomer is about 1.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 35 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 35.

Claim 36 depends from claim 35 and further recites that the polyurethane is formed from 4,4'-methylene bis-phenylisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and 2,4 pentanediol.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the

polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 36 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 36.

Claim 37 depends from claim 36 and further recites that the secondary diol is 2,4-pentanediol.

As discussed above with respect to claim 20, Zeigler in view of Manzara et al., Manser, and Ochoa Gomez et al. do not disclose or suggest a thermoplastic elastomer that comprises a polyurethane and that the amount of aromatic diisocyanate, linear energetic polymer, and 2,4 pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1. Therefore, claim 37 is allowable for the same reasons as claim 20 and for the specific limitations recited in claim 37.

In view of the foregoing, it is respectfully submitted that the above-identified application is in condition of allowance, allowance of the above-identified application is respectfully requested.

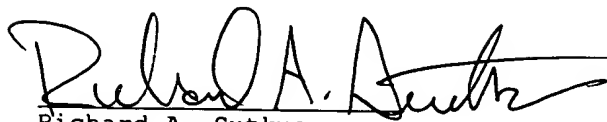
Attached hereto is a marked-up version of the changes made to the specification by the current amendment. The attached page is captioned "Version with markings to show changes made."

Please charge any deficiency or credit any overpayment in the fees for this amendment to our Deposit Account No. 20-0090.



Serial No. 09/553,137

Respectfully submitted,

A handwritten signature in dark ink, appearing to read "Richard A. Sutkus", written over a horizontal line.

Richard A. Sutkus

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**VERSION WITH MARKINGS TO SHOW CHANGES MADE**

**In the Specification**

The paragraph beginning at line 5, of page 3, has been amended as follows:

--The present invention is an apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited, produces gas to inflate the inflatable vehicle occupant protection device. The gas generating material comprises a polyurethane thermoplastic elastomer and an inorganic salt oxidizer. The polyurethane elastomeric material comprises a physically cross-linked linear ~~block~~ copolymer of an aromatic diisocyanate and a linear energetic polymer having a hydroxyl functionality of two or less.--

**In the Abstract**

The abstract has been amended as follows:

--An apparatus (10) comprises an inflatable vehicle occupant protection device (20) and a gas generating material (16) that, when ignited, produces gas to inflate the inflatable vehicle occupant protection device (20). The gas generating material (16) comprises a polyurethane thermoplastic elastomer and an inorganic salt oxidizer. The polyurethane elastomeric material comprises a physically cross-linked linear ~~block~~ copolymer of an aromatic diisocyanate and a linear energetic polymer having a hydroxyl functionality of two or less.--

IN THE CLAIMS:

Claim 20 has been amended as follows:

20. An apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited produces gas to inflate the inflatable vehicle occupant protection device, the gas generating material comprising:

an inorganic oxidizer salt; and

a thermoplastic elastomer, said thermoplastic elastomer ~~being~~ comprising a polyurethane formed from an aromatic diisocyanate, a linear energetic polymer with a hydroxyl functionality of two or less, and optionally a ~~secondary diol~~ 2,4-pentanediol, wherein the amount of aromatic diisocyanate, linear energetic polymer, and ~~secondary diol~~ 2,4-pentanediol used to form the polyurethane are controlled so that the ~~the~~ ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Claim 30 has been amended as follows:

30. The apparatus of claim 20 wherein said polyurethane is formed from an aromatic diisocyanate, a linear energetic polymer with a hydroxyl functionality of two or less, and a ~~secondary diol~~ 2,4-pentanediol.

Claim 32 has been amended as follows:

32. An apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited produces gas to inflate the inflatable vehicle

occupant protection device, the gas generating material comprising:

an inorganic oxidizer salt; and

a thermoplastic elastomer, said thermoplastic elastomer ~~being~~ comprising a polyurethane formed from an aromatic diisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and optionally a ~~secondary diol~~ 2,4-pentanediol wherein the amount of aromatic diisocyanate, glycidyl azide polymer, and ~~secondary diol~~ 2,4-pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to the hydroxyl groups used to form the polyurethane is about 1.

Claim 35 has been amended as follows:

35. An apparatus comprising an inflatable vehicle occupant protection device and a gas generating material that, when ignited produces gas to inflate the inflatable vehicle occupant protection device, the gas generating material comprising:

about 65% to about 90%, by weight of the gas generating material, an inorganic oxidizer salt; and

about 5% to about 35%, by weight of the gas generating material a thermoplastic elastomer, said thermoplastic elastomer ~~being~~ comprising a polyurethane formed from 4,4'-methylene bis-phenylisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and optionally a ~~secondary diol~~ 2,4-pentanediol, wherein the amount of 4,4'-methylene bis-phenylisocyanate, glycidyl azide

polymer, and ~~secondary diol~~ 2,4-pentanediol used to form the polyurethane are controlled so that the ratio of isocyanate groups to hydroxyl groups used to form the polyurethane is about 1.

Claim 36 has been amended as follows:

36. The apparatus of claim 35 wherein the polyurethane is formed from formed from 4,4'-methylene bis-phenylisocyanate, a glycidyl azide polymer with a hydroxyl functionality of two or less, and a ~~secondary diol~~ 2,4-pentanediol.